

To Ruine a World

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My text and title are taken from Fontenelle's *Plurality of Worlds*, written in 1686, from which I quote. . . .

"How," cried the countess, "can suns be put out?" "Yes, without doubt," said I, "for people some thousands of years ago saw fixed stars in the sky which are now no more to be seen. These were suns which have lost their light and certainly there must be a strange desolation in their vortexes." "You make me tremble," replied the countess. "O madam," said I, "there is a great deal of time required to ruine a world."

My thesis is that Fontenelle was wrong, or at least that he would be wrong if he said the same words today, and that a great deal of time is *not* required to ruin a world. Man, in just the short part of this earth's history that he has been present, has gone far toward creating ruin, and especially in those parts of the earth where educational opportunities and material prosperity would appear to offer the greatest opportunity to improve on rather than to detract from Nature's handiwork.

The views that I express are subjective and stated from the anthropocentric viewpoint that what is bad for mankind is bad for the world. On the other hand, the objective view of the geologist must be that mankind has come and will go, leaving little evidence of his presence or handiwork, and leaving the earth little the better or worse for his ephemeral presence or for his passing. I mean by this that man's activities, wondrous as they may have been at times and at places, and catastrophic as they have been and are now over much of the earth's land area, are insignificant in comparison with the inanimate changes, and even some related to the plants and animals, of the past. That past, we must presume, permits prognosis for the future, just as the doctrine of uniformitarianism states that the present is the key to the past. Within the part of geologic history recorded reasonably well in the interpretable rock record, mountain-building and continent-building forces have caused vast expansions and contractions in both the area and the height of the lands. Surface volcanism has buried tremendous land areas, increasing the amount of land in some instances, and leading to the terranes and soils that have permitted the flowering of economies and cultures. In the geologic past the evolution and proliferation of certain plant and animal strains have changed the earth's surface, or at least substantial parts of it, to a degree that would have occasioned the outcry "this means the end of the world as we know it" had there been a voice to speak.

To return, however, to the view that the world is being ruined, in the sense that the more desirable parts of it are becoming less acceptable as an abode for mankind, the ruin of which I speak is taking place in three ways: first, we are strewing the surface and filling the shallow subsurface with waste to an extent that further constricts the amount of usable land and makes even that area less tolerable, and we are making much of the air and fresh water unfit for human consumption. Second, we are destroying the accomplishments of the past. Third, we are consuming our irreplaceable natural resources at a rate that suggests subconscious acceptance of the view that man's occupancy of this planet will be short.

The air is being spoiled with noxious gases and dusts. Surplus water vapor and carbon dioxide are being added to the atmosphere at a rate that will affect world climates.

Water is being contaminated with chemicals—some of them poisonous—sewage, industrial wastes, and sediment, and the heat balance is being changed by thermal pollution.

Our soils are being destroyed, covered, or made unusable by paving and stripping, by being covered with trash and garbage, and by being buried under subsoil materials in our determination to alter the natural topography.

Biologists are particularly familiar with those factors that are acting to disturb natural environmental balances, and they have been fortunate in having such persons as Rachel Carson to speak against tampering with the environment before adequate study of the consequences. How great our debt to those who force us to review the effects of our errors! And how fortunate if the warnings come in time!

But the aspect of ruin in which I may be best qualified to speak is that related to geology. The exploitation of ores for their essential purpose of yielding metals has led to extensive destruction and pollution at both the mining and the smelting levels of development. Landscape alteration is inherent in removal and processing of mineral raw materials, and the problem thus becomes one of utilizing the mineral commodities for man's benefit without, in the process, creating damage that will result in a net loss to man's long-term welfare. Many pit, quarry, and mine operations are conducted in a manner that is efficient in terms of present-day dollar profit and loss but inefficient in terms of long-range land use. Few deposits are worked in a manner that will recover the largest amount of usable material from the minimum number of acres of land used or ruined. Some encouragement is to be found in the fact that an increasing number of mineral producers, principally in the non-metals construction materials and numbering very few among the metal-mining companies, plan their land use programs with an eye toward rehabilitation and even improvement of the terrane as their acreage is worked out.

It is a curious paradox that as we have more demand for water we have less respect for its beauty. It is also a paradox that as personal and

domestic cleanliness increases we should tolerate a landscape in which trash is more and more evident. To a considerable extent this results from a complete breakdown in the scavenging system—or the salvage system, to use a more polite term. In all earlier societies, and in many societies today, waste had too much value to remain a blight on the landscape. Mayhew recorded (*London Labour and the London Poor*, 1851) the degree of specialization that characterized salvage in the Victorian London of his day. For each type of discard material, different scavengers came to the doors, some buying old iron and various others buying grease, drippings, broken metal, old umbrellas, rabbit skins, waste paper, glass, old bottles, and old clothes. Other scavengers, gathering waste from the streets and river flats, were classified as bone grubbers, rag gatherers, trampers, mud-larks, pure-finders, and other named specialists, and in addition to the activities implied by their names they collected waste metal—the most valued material—rags (which they sorted into lots of white or colored for the paper makers and into canvas and sacking for other purposes), cigar ends, old wood, chunks of coal, waste paper, and every salvagable discard. Mayhew estimated their number at 800. Dust contractors, who numbered 80 or 90, were paid by the city to remove ashes and cinders, and they sifted the ash for resale as soil conditioner and raw material for brick.

No generation younger than mine has heard the street cry (or alley cry, to be more precise) "Any rags, any bones, any bottles today?" In many systems all the trash, garbage, and other discarded materials are loaded into one truck and hauled to some spot at which fuel is consumed to incinerate them or land is used to stack them or bury them—generally without regard to the possible polluting effect on ground water. The industries that once depended, entirely or in part, on waste and scrap have ceased or gone to other materials. As an example, an essential ingredient of the glass industry is the material called cullet, which is broken glass. It was formerly salvaged and sold as clear, colored, or mixed cullet. Its function in the glass furnace is to provide nuclei of vitrification that speed and improve the melting process. Most glass companies make their own cullet today. Whatever they are making when the need arises—fancy decanters, pickle bottles, or anything else, feeds off the conveyor belt onto a concrete floor to provide cullet, while the waste glass of our society fills acres of our landscape. Not only will it defy the process of weathering for thousands of years; it makes the soil untillable and dangerous to walk on or work with. The Romans avenged themselves on Carthage by plowing the site and sowing it with salt. The way modern society treats itself and future generations makes the Romans' treatment of their vanquished enemies seem tender-hearted.

The first step in the war against solid waste would be a strictly-enforced program of presorting by users. Trash would be sorted into newsprint, magazines, glass, cans, waste metal, and burnables (penalty for non-compliance: a day at the dump, sorting). Refuse would have to be separately collected, on a rotating schedule if necessary, and separately processed. The cost of collecting and policing would be balanced by the

saving in land-acquisition costs, by salvage, and, of course, by aesthetic appreciation in land values.

The second step in the war would involve large-scale reforms in packaging. Our present methods use resources at an inexcusable rate and compound the damage by contributing excessive waste.

Among the accomplishments of the past, man has, over the centuries, adorned the earth with gardens and groves, bridged rivers, laid roads, and built homes and public buildings, the most splendid of which have been ecclesiastical. The skill, patience, and effort they cost have been prodigious, and the artistic achievements they represent humble us in these late untalented days. The apprentice system, in spite of its severities, raised up craftsmen, which our kinder modern society cannot replace. Their handwork is irreplaceable and deserves our protection. This country has been even more careless about its historic buildings than European countries, but here and there an aesthetic conscience is beginning to inspire preservation programs. The State of Indiana needs more civic efforts of the kind typified by Historic Madison, Inc., and the State and private activities at New Harmony in the fields of historic preservation and restoration.

As a total environment for mineral resources we could say this about the earth: by chance we live on one of nine known planets in a minor solar system that forms an obscure part of one of the lesser galaxies. We are concerned with a very small fragment of the total matter in the universe. We are inhabiting this planet only transiently, our entire history as a human race having occupied but one million years of the four billion years of known geologic time. My point in mentioning this transience is that the earth's mineral resources are different from period to period in geologic time. There would have been a place in the geologic time scale, undoubtedly, when the earth's mineral resources would not have included oil and gas. Organisms either were not present or were not abundant enough to furnish the hydrocarbons that constitute oil and gas. We know quite precisely the place in geologic time at which there would have been no coal resources—no members of the coal family that includes lignite, peat, bituminous coal, or anthracite—because the first coals appeared with the development of vascular tissue in plants late in the Devonian Period.

Similarly, before a certain point in geologic time, there would have been few iron ores of the kind we regard as commercial now, and conversely, because the greater part of our commercial iron ores are Precambrian, meaning that they are 550 million years old or more, there was a time in earth history when iron ores of the type that we consider commercial today were vastly more abundant than they are now. Most of the iron ores of this kind have undoubtedly disappeared through the processes of weathering and erosion since that time which was most favorable for their accumulation.

All mineral deposits are theoretically exhaustible, as sufficient use would ultimately consume all of anything at the earth's surface. Materials that can be removed from the sea are almost limitless so far as their

reserves are concerned. One other type of mineral resource may also be classed as practically limitless, meaning that man's use will not exhaust the supply, and these are the materials that occur as common rock types. We shall never run out of an adequate supply of granite to keep us all in tombstones. We shall never lack an adequate supply of basalt, limestone, dolomite, and other such materials to crush for concrete aggregates and road metal. We shall never run out of salt because it is a relatively common rock type, and even if we could not extract limitless quantities from the sea, we could mine salt virtually forever without exhausting the world's supply.

Even after using these dangerous words, *limitless* and *inexhaustible*, I feel obliged to tell you that most of the mineral deposits that have been called *inexhaustible* have long since been exhausted. The gas supply that caused northern Indiana and western Ohio to be settled and industrialized in the 1880's and 1890's was called *inexhaustible* in every county newspaper in the two states, but specifically it lasted as a good source of supply for less than 25 years, in large part because it was wasted, but if the best of conservation measures had been applied to it, the life expectancy would still have been less than 50 years. Most *inexhaustible* mineral resources *have* been exhausted, and most of the ones we now *call* *inexhaustible* are likely to be exhausted unless they are fairly common rock types or obtained from the sea.

The fossil fuels offer some of the most striking examples of the interrelationship between mineral resource needs, the pattern of our society, and man's prospects for a tolerable future. The problems involved in the removal and use of the solid fuels are no greater than those in the liquid, gaseous, and nuclear fuels, but they are more visible.

Coal mining, whether by stripping or by underground workings, necessarily disrupts the surficial environment. The surface effects of stripping are the more apparent, and the subsidence effects of shallow underground mining more delayed. Land reclamation is extensive and growing in our own State and certain other regions in which the strata are flat-lying and the natural topography subdued. In Indiana more strip coal land undergoes some reclamation treatment per year than is newly mined, but in regions of steeply dipping coal beds and rugged topography it is inevitable that many acres of land will be destroyed for every acre of coal recovered. Reclamation can accomplish little in those terranes, and the only answer, if there is an answer, is rigorous restriction and regulation of surface and near-surface coal mining.

There is no more striking example of the enormous increase that has taken place in per capita consumption than in the domestic use of fuel or heat energy from fuel. Less than a century ago the average household heated a scant three rooms, of perhaps a much larger housing space, with small open fires, in many instances burning wood, in which case the summer's growth supplied the winter's warmth. In many social orders a community oven provided most of the heat for baking, and one hot meal a day was the accepted pattern. Now, in our society at least,

enormous cubages of space are kept at summer temperature all winter by fossil fuel, and at spring's temperature all summer, also by fossil fuel, and empty houses—weekend houses as the fashion calls them—are kept at 55 or 60 degrees to be instantly usable should whim suggest their temporary occupancy—an extravagance with few parallels in history.

In the energy field we have laid out our homes, our towns, and our communications on the premise that cheap petroleum products will be available indefinitely. By analogy the British laid out their social order in the cheerful delusion that cheap domestic help would always be abundant. Their economic dislocation, when things changed, was and continues to be drastic. Our dislocations, when the energy sources dwindle or price themselves out of our market, will be catastrophic.

By way of review in this field of energy sources, let me say that one of the most respected estimates calculates 200 billion barrels of total recoverable petroleum. Of this amount 85 billion barrels have been produced and used to date. A reasonable projection indicates that the remainder will last 65 to 70 years, at progressively increasing cost. Naturally the day will not come when *all* oil has been found and produced and used, but by the time the indicated date arrives the discovery-production-consumption ratio will have reached that point at which the liquid and gaseous fossil fuels will no longer supply a significant part of our energy needs.

Coal reserves will suffice for several more centuries, even considering the inevitable shift to coal for energy needs filled now by other materials.

Nuclear energy will be required in increasing amount to phase out both solid and liquid-gaseous fossil fuels, but present methods of developing nuclear energy cannot keep up with the required increase. Only breeder reactors, which are estimated to be 20 years away so far as extensive development is concerned, can provide the needed energy supplement for short-term purposes, and they will produce toxic wastes beyond our ability to cope with them. Only fusion reactors, which are estimated to be 40 years away, but which will *not* produce toxic wastes, can give long-term energy security.

In the non-fuel mineral industries, both reserves and outlook vary tremendously, and the two are not the same and are, in fact, not entirely correlatable. Reserves are known supplies recoverable by mining, and the known reserve divided by annual consumption gives an indicator, expressed in years, called the reserve-consumption index. An index as low as 25 years is no occasion for concern in the case of a commodity for which we believe that the reserves can be extended through exploration programs; numerous mineral substances fit this category. A reserve-consumption index of 25 years *is* alarming in the cases of those commodities for which the prospects of significant additional reserve discoveries appear to be dim. The answer to a supply failure for some minerals may be found in substitution. Tin, as an example, had a 25-year reserve-consumption index in 1964, and the prospects for additional major dis-

coveries are poor. Yet the major use of tin—plating—is one for which substitutes, not as good and not as economical, but still acceptable, are possible.

Both mercury and silver, with 1964-65 indices of 14 and 23 years respectively, are metals for which the index is likely to be extended through additional discovery, but even so an adequate supply is probably short-lived, and each has essential uses for which no substitute is available at an economic level.

All reserve-consumption indices are likely to change with new discoveries and with alterations in uses and technology, and so I prefer to deal with our overuse of mineral resources on a basis that cannot, I believe, be denied: we waste them prodigiously. As a person who has spent a considerable number of years in searching for mineral resources, I am distressed by the upsurge of such things as the throw-away bottle. When my children bring home soft drinks in these containers, I wonder whether the two minutes of pleasure derived from their consumption has justified the exploration and production effort for high-silica glass sand, feldspar, borax, and other ingredients of a rather high-quality container which must have greater intrinsic value than the syrupy mixture it contains. The aluminum beer can that is discarded after use would be the most valued household possession in some underdeveloped societies.

To compound the difficulties presented by these examples, both items become particularly durable elements in our growing amount of waste materials, and each will survive the process of weathering better than man himself. One of the principal reasons that life has expanded and survived so successfully on this planet is that organisms are disposable and in fact decay to enhance prospects for living things in the future rather than the reverse. Many organisms have, in a sense, left their bodies to science and have contributed to the limestones, clays, shales, coal beds, and oil and gas accumulations on which we now depend, but man is the first organism to leave artifact offal that may act to stifle life on the planet.

Water is everyone's problem, and the geologist's role is to locate ground water, establish sites for surface reservoirs, assist in matters of drainage and flooding, and do his part in preventing pollution of both surface waters and subsurface waters.

Water differs from all the other inorganic materials we require in that it alone has ethical implications. Present-day Western morality judges countries and people with respect to cleanliness of their persons and households—in other words on the basis of the amount of water available for plumbing, laundering, and bathing. Neither the courtesy and competence of the population, the harmony of the architecture, or the order and tidiness of housekeeping are as important as available surface or subsurface water and the means of conserving and supplying it. One may categorize a populace as arrogant, parsimonious, drunken, lazy, dishonest, immoral, or even cowardly and still encounter only an agitated rebuttal, but call it dirty and relations are terminated.

Some sort of ceremonial washing and purification has been a feature of most religions. Basins or fountains for ritual ablutions are architectural features of their places of worship, as in the great European baptisteries, and they hold sacred certain rivers, springs, or lakes. I think it possible that some of the revulsion we feel at today's dirt-cults among the young is not just a generation gap but a natural response to a perversion of a deep human instinct. The urge to feel clean is innate, perhaps phylogenetic and related to the fact that life came from the sea, but most societies until ours have been, or have been obliged to be, realistic about personal water consumption. We are not realistic. On a few occasions in my youth I broke ice in a pitcher to wash in the morning—a commonplace occurrence one generation earlier—my son is incensed if a 20-minute hot shower is criticized.

This assumption that moral superiority and personal cleanliness are mutually dependent causes great international strain. In much of Asia, for example, if all the available water in the populated regions could be collected and piped to users, there still would not be enough per capita to operate a sanitary sewage system—much less provide water for industry or irrigation.

That society is most enlightened that best lives in harmony with its environment and secures that harmonious relationship for future generations *ad infinitum*. It is time to adjust our personal requirements to realistic per capita use of energy and raw materials, and we are overdue for a disinterested examination of our environment and establishment of a regimen to insure our national health and longevity. A great annual outcry is heard about the national deficit. The need to balance our resource budget is of far greater importance to this nation than is the balancing of the fiscal budget.

Peter Blake concluded his eloquent book *God's Own Junkyard* with these sobering words: "The inscription on Sir Christopher Wren's tomb in St. Paul's Cathedral contains these famous words: 'If thou seek his monument, look about thee.' God forbid that this should ever become our epitaph. . . ."